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MARINE PHYSICAL LABORATORY ✓

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*Quarterly Progress Report*

1 April 1955  
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Approved for distribution:

*Roger Revelle*

Roger Revelle, Director  
Scripps Institution of  
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## SCIENTIFIC STAFF

Sir Charles Wright, Director, Marine Physical Laboratory  
(to May 18, 1955)

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Alfred B. Focke, Ph.D., Research Physicist, Prospective Director

Leonard N. Liebermann, Ph.D., Associate Professor of Geophysics

Russell W. Raitt, Ph.D., Associate Professor of Geophysics

Philip Rudnick, Ph.D., Associate Research Physicist

Fred N. Spiess, Ph.D., Associate Research Physicist, Acting  
Director (from May 18, 1955)

Victor C. Anderson,\* Ph.D., Associate Research Physicist

George G. Shor, Ph.D., Assistant Research Physicist

Finn W. Outler, USN (ret), Technical Superintendent

Tom A. Magness, MA, Graduate Research Physicist II

William Whitney, AB, Graduate Research Physicist II

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\*On Leave of Absence at Harvard University until September 1955.

## GENERAL

On May 18, 1955 Sir Charles Wright retired from the directorship of the Marine Physical Laboratory to return to his home in Victoria, B. C. His leadership and broad background in naval research have been greatly appreciated here and in many other U. S. Navy scientific establishments during his two and one-half years as Director of the Marine Physical Laboratory. Dr. A. B. Focke, at present directing Project Wigwam, will assume the post of Director at some future date, probably shortly after July 1. In the interim, Dr. F. N. Spiess is the acting Director.

This quarter also saw the return of Mr. T. A. Magness (June 21) and Mr. William Whitney (June 7) from UCLA to work with us for the summer. Another graduate student, Mr. F. H. Fisher of the University of Washington, joined the staff on April 18 and Mr. J. S. Margolis, a graduate student at UCLA, joined us on June 20. Both hold the position of Graduate Research Physicist I.

Dr. Shor visited Los Angeles in mid-April to discuss seismic refraction work with Dr. B. Gutenberg at California Institute of Technology and to give a lecture (abstract appended) on seismic refraction techniques at sea to the Pacific Coast Section of the Society of Exploration Geophysicists.

Dr. Liebermann spent April 29 at UCLA conferring with Drs. R. E. Holzer and O. Deal on the attenuation of very low-frequency radio waves, and discussing this topic and the problems of bubble formation with Dr. Eckart, who spent most of the quarter at UCLA conducting a seminar on flow in stratified media.

During May, Dr. Spiess spent several days in Washington, D. C., discussing MPL projects with various groups at ONR and Bureau of Ships, and attended an ONR conference on usefulness of bathyscaphes in oceanic research. He also visited Dr. Anderson at Cruft Laboratory, Harvard University, to observe operation of the first completed model of Anderson's Deltic (delay line time compressor).

In mid-June, Dr. Rudnick visited U. S. Navy Underwater Sound Laboratory and the Applied Science Research Laboratory of the University of Cincinnati. At the latter place he discussed with Dr. Walter Soller the possible application of the electromagnetic log to the study of turbulence in the ocean.

Drs. Focke, Rudnick and Spiess attended the Eleventh Navy Symposium on Underwater Acoustics and the Acoustical Society of

America meeting at Pennsylvania State University, University Park, Pennsylvania. Dr. Spiess and Dr. Rudnick both presented papers at the symposium.

Three groups visited the laboratory during this period. Dr. L. J. B. LaCoste and Messrs. J. G. Cobb and R. L. Burris of LaCoste-Romberg Company and Mr. A. L. McCahan of the U. S. Navy Hydrographic Office visited Dr. Spiess prior to the sea test of Dr. LaCoste's gravimeter (see report under MPL Problem 8). On April 21, Messrs. J. S. Johnson and R. L. I. Fjarlie of the Pacific Naval Laboratory of Esquimalt, B.C., visited the laboratory to exchange information on projects underway at our respective laboratories. Mr. F. J. Reilly, Scientific Adviser at the British Joint Services Mission, visited Dr. Focke on June 10.

In addition to the usual quarterly contributions, one confidential report "Field Measurements for an Electric Dipole Submerged in the Sea," by Dr. P. Rudnick and J. M. Snodgrass, SIO Reference 54-30, dated 14 May 1954, has been distributed.

#### Exploratory Research (Problem MPL-1)

##### OCEANIC TURBULENCE - F. N. Spiess

An instrument to investigate vertical accelerations in the ocean is under development, and the first model was tested at sea in May. The instrument consists of an accelerometer whose output is a frequency which is approximately linearly proportional to the acceleration. In this first model the frequency was about 8 kc and the sensitivity  $0.15 \text{ cm/sec}^2$  per cps. No attempt was made to use an electronic system with low-temperature coefficient, nor to thermostat the equipment in this early model; consequently the absolute value of the acceleration-versus-frequency relationship was subject to gradual drift. The accelerometer is housed in a pressure-proof case which is provided with a Bourdon tube pressure gauge which drives a potentiometer. Two signals are led up the wire to the boat--one an  $8 \pm 1 \text{ kc}$  signal giving the acceleration and the other a dc signal giving the depth. The pressure-proof case is almost neutrally buoyant, and the wire available is fairly long (about 3000 feet). The familiar slack-wire, slowly-rising-case technique is used, with an excess weight attached to a hydrostatically actuated weight dropper to provide the initially desirable negative buoyancy.

The equipment operated successfully, making three hovering runs at about 700 feet. In each run there were no variations of acceleration with time over periods of several minutes within the limits of accuracy of the system as it existed at that time. Quantitatively this means that the fluctuations having characteristic times of one second to a few minutes were less than  $0.6 \text{ cm/sec}^2$ , in a sea state of one.

The sensing element and electronic system are now both being altered. It is expected that sensitivity can be pushed to give accuracy of 1 cps with 1 second integration time. Further sea tests and instrument improvements are planned for the coming quarter.

#### Seismic Studies (Problem MPL-5)

#### REFLECTION AND REFRACTION OF EXPLOSIVE WAVES BY THE SEA BOTTOM - R. W. Raitt and G. G. Shor, Jr.

Work continued on the analysis of records from previous expeditions, principally the Cusp Cruise and Acapulco Trench Expeditions.<sup>1/2/</sup> In both regions covered by these cruises the surface mixed layer was usually very thin or absent. Consequently, direct propagation between shot and hydrophone was usually poor and shot distances more difficult to determine than in the central equatorial regions covered by the Mid-Pacific and Capricorn Expeditions, where deep mixed layers generally provided excellent direct transmission. Determination of the distances from the travel time of waves reflected from the bottom and refracted through the deep bottom water on the Cusp Cruise was facilitated by IBM ray calculations made by Mr. L. A. Gardner of Hudson Laboratories, arranged through the help of Mr. A. P. Boysen, Jr., of Bell Telephone Laboratories.

On most of the reflection records from the Eupelagic Area obtained during the first section of the Acapulco Trench Expedition<sup>2/</sup> one strong reflection from below the bottom was obtained. In many cases this echo was strong enough so that second multiple

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<sup>1/</sup>Marine Physical Laboratory Quarterly Progress Report, 1 July 1954 through 30 September 1954, SIO Reference 54-39 (27 December 1954).

<sup>2/</sup>Marine Physical Laboratory Quarterly Progress Report, 1 October 1954 through 31 December 1954, SIO Reference 55-4 (11 February 1955).

(reflected at the sub-bottom horizon twice and at the water surface once) were obtained. In a few cases the third and fourth multiples were recorded. This reflection presumably comes from the basement below the sediments.

Data were taken along the north-south lines perpendicular to the boundary between areas of clay and carbonate bottom. When the time interval between the bottom and basement reflections is considered as a function of latitude, the data fall into two groups as shown in Figure 1. The principal group fits the line  $T = 0.52 - 0.027 L \pm 0.05$  seconds over the range of work from  $3^{\circ} 30'$  to  $13^{\circ}$  N, where  $L$  is in degrees north latitude. Members of the smaller group show no significant latitude variation, and follow the line  $T = 0.26 - 0.006 L \pm 0.02$  seconds. In no case are points fitting both lines found at the same location.

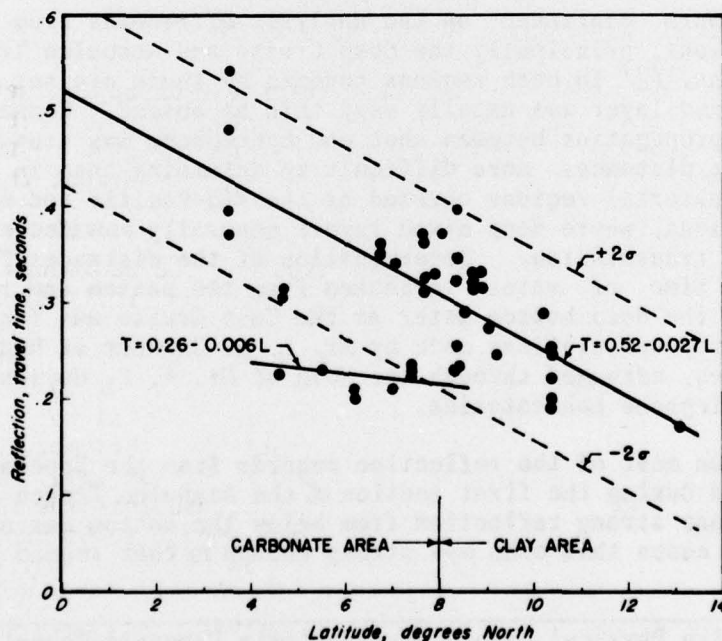


Figure 1. Sediment reflection time as a function of latitude.

Correlation of reflection time interval with bottom depth over the area is not as strong; the relation for the main group of points of reflection time interval with latitude and water depth (expressed as bottom reflection time) is

$$T = 0.52 - 0.027 L + 0.11 (S_1 - 6.17) \pm 0.04 \quad \text{sec}$$

where  $S_1$  is the echo time from the top of the sediment. This indicates that the sediments are definitely thicker to the south, and are slightly thicker in the areas of deeper water. The variations from the mean are accountable 57 percent by latitude, 12 percent by water depth. The remainder is in part due to errors of reading, but probably also in part to effects of local topography and geology.

At stations 10 and 11, in the area of clay bottom, five records showing good basement reflections were obtained in a small area. Two of the shots were over a hilltop; three were over an adjacent flat-bottomed valley 90 fathoms deeper. The sediment travel time was greater in the valley, with a ratio of sediment time difference to water time difference of 0.19 instead of 0.11 as obtained for the area as a whole.

The decrease in sediment thickness of approximately 30 meters per degree of north latitude is probably an expression of the greater amount of material that has accumulated in the carbonate area. There is no sudden increase in sediment thickness at the present boundary, although there is steepening of the curve shown in Figure 1, which indicates variation of position of the boundary during the time of deposition of the sediments. The small group of points with noticeably smaller reflection time than the main group may represent a lava flow within the sedimentary section. The lesser thickness of sediment on the highs receives confirmation in the finding by Bramlette <sup>3/</sup> that in cores from the tops of hills Miocene or Oligocene material was obtained at or within a meter of the surface, but that this material was not reached in the short cores obtained in the basins. The reflection data at stations 10 and 11 indicate that the material transported from the high to the low may amount to as much as 50 meters, although some of this difference in thickness may be pre-Oligocene. The results at stations 10 and 11, and examination of the bathymetric charts compiled by Fisher, indicate that because of the lack of interconnection between the basins the actual

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<sup>3/</sup>ONR, The Earth Sciences Progress Report, Number 35, SIO Reference 55-18 (15 May 1955).

amount of transport from highs to lows is greater than indicated by the regional correlation of sediment thickness with water depth since the relative erosion and deposition in an area with closed basins should be more closely related to position with regard to the local base-level than to absolute water depth.

Considerable time was spent in preparation for a trip planned in July to investigate deep structure in the region of the continental slope and continental borderland west of San Diego. This trip has been postponed until September. Work was also done on analysis of past borderland data.

**Assist Other Navy  
Sponsored Activities  
(Problem MPL-8)**

**GRAVITY MEASUREMENTS AT SEA -  
F. N. Spiess**

On April 4, Dr. L.J.B. LaCoste and two of his technicians, Messrs. J. G. Cobb and R. L. Burris, arrived at MPL to set up the LaCoste-Romberg submarine gravimeter for testing prior to embarking in USS BESUGO for Astoria, Oregon. Tests were completed satisfactorily and the equipment was loaded on board the submarine on April 7.

En route to Astoria, 17 stations previously occupied using the Vening-Meinesz pendulum equipment, were reoccupied using the LaCoste gravimeter. The results were quite good, the rms discrepancy between the two sets of observations being 4.0 milligals, comparable with the reproducibility of observations at sea with the pendulum equipment.

Since the chief errors probably arose from discrepancies in position and current determination, plans are being made to install both equipments in the same submarine and make simultaneous observations, perhaps during the next trip, tentatively planned for late September. At the present time this instrument appears to be very promising. No great advantage in weight or complexity is obtained, but the fact that results are available immediately makes this a distinct improvement in method.

## OFFSHORE SEISMIC REFRACTION WORK\*

G. G. Shor, Jr.

A B S T R A C T

Past refraction studies at sea by the Marine Physical Laboratory of the Scripps Institution of Oceanography have been devoted principally to studies of bottom structure in the deep-sea areas, with only a small amount of work in shallow water. Recently more work has been done in the shallower water of the Southern California Continental Borderland, approaching the near-shore areas where commercial seismic work is being done. One 100-mile line from San Diego to Santa Barbara Island and numerous shorter lines have been shot. Velocities near 22,500 ft/sec exist at depths near 25,000 feet under this area, as found by Tuve in 1950 farther east in the Southern California batholith. Such high velocities at shallow depth have not been detected in California north of Los Angeles Basin. Because of these shallow high velocities, arrivals from the Mohorovičić discontinuity have not been obtained although under continental structure a 100-mile line would normally detect these arrivals. Cross sections showing tentative interpretations of shorter lines are shown, and it is pointed out that there are indications of the existence of a sedimentary basin under the edge of the continental shelf west of Point Loma. Differences between the research refraction program and the commercial reflection work offshore are discussed, and some of the problems encountered and methods used are described.

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\* Presented as a talk to the monthly meeting of the Pacific Coast Section of the Society of Exploration Geophysicists in Los Angeles on 14 April 1955.

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